INFLUENCE OF THE FEATURES OF GRAPE DIETARY FIBER PRODUCTION ON THE TECHNOLOGICAL PROCESS OF WINE

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Abstract

In order to improve the technology of natural table wines, the use of secondary raw materials in the wine industry, in particular grape marc was investigated. The skin of the grape berry was taken as a secondary raw material in the research, either in fresh or dried and powdered form or in the form of dietary fiber. In this regard, a research was conducted on the marc that was obtained using modern technological equipment and grape processing technology. Grape dietary fibers, obtained as a result of two drying methods based on our technology - infrared radiation and drying cabinet, were used during the experiment. The obtained results proved that the chemical composition of wine materials is more influenced by the type of drying of grape dietary fiber, rather than the degree of grinding. Based on scientific research, it can be noted that infrared drying provides the best quality grape dietary fiber, and these grape dietary fibers have a positive impact on the wine process.

Key words: wine, grape, grape dietary fiber, physico-chemical and sensory evaluation.

Introduction

The waste rich in dietary fiber remains after the process of food production in food industry. Their use has always been of special interest for the production of new food assortments and the enhancement of the biological value of food. The food industry waste consists of many high-grade proteins, oils, easily digestible carbohydrates, macro- and micronutrient elements, vitamins and other substances. However, raw materials obtained from grape processing are used infrequently and inefficiently. However, there is no doubt that the use

of dietary fiber obtained from these raw materials in the food industry and winemaking can bring even greater income [13, 14].

In connection with the beneficial effects of dietary fiber of plant origin on human health, vegetable fibers have found their application in food fortification [31, 5, 16, 20]. Dietary fiber can also improve the quality by having a positive effect on physical and chemical parameters.

It is known that the use of grape powder increases the nutritional value and stability of yoghurt [3]. Moreover, a soft cheese recipe has been developed by adding grape powder to cow's milk. This has had a positive effect on the organoleptic and consumer properties of the product [8, 32].

Italian experts have proven the perspectiveness of using grape powder in the production of marmalade sweets and its great potential for the confectionery industry. The enrichment of marmalade with grape powder increased the amount of anthocyanins, flavonoids and procyanidins, as well as antioxidant activity that has ensured stability during production. In addition, sweets enriched with fibers showed good textural properties, and the production duration was reduced [15].

There are researches that have proven that dietary fiber derived from grapes is an effective inhibitor of lipid oxidation [2]. According to these studies, it is recommended to use them as a natural antioxidant in raw chicken meat and sausages [10]. However, relatively few studies have been conducted in this direction, and experimental data are not systematized. The use of dietary fiber obtained from grapes in the wine industry itself, including in the intensification of the production process of natural wine, has not been studied yet.

The skin of grape berry contains such valuable components as polyphenols, lignins, flavoring materials, colorants and minerals, amino acids and vitamins. In addition, the skin of grape berry contains other components, including hemicellulose, cellulose and phenylpropanolignin that formes polysaccharide-lignin complex, which makes up dietary fiber [6, 7, 12]. Based on the analysis of results of the research on the processing and use of secondary raw materials in the food industry, it can be assumed that the production of dietary fiber from grape marc is promising and can be used not only in the baking, canning and dairy industries, but also for improving the technological methods of natural table wines. It is also important as only natural components of grapes will be used in their production, which will further enhance their naturalness.

Objects and methods of research: Four options of the grape marc processed with crushers-destemmers were taken as the objects of the research. The marc (sweet marc) that remained after the separation of the wort from the mixture of white grape varieties was taken in the first option. Since it contains unfermented sugar, it is called a sweet marc. The sweet marc obtained from a variety of pink grapes was taken in the second option, marc obtained from red grapes and matured in the pulp was taken in the third option, and the marc fermented from red grapes was taken in the fourth option.

Furthermore, wine materials and grape dietary fibers were taken as the object of the research. Dry yeast Sacharomyces cerevisaiae was used for the fermentation of grape juice. The freshness of the raw materials has been verified by inspection [33].

A systematic and technological approach was applied in order to achieve the target goal. This technique is based on the analysis of the product at all stages of its processing. Yield indicators (elements of fruiting), as well as chemical indicators of the yield of grape varieties were studied using traditional and modern methods [9, 17-19]. The actual data obtained during the research were processed by mathematical and statistical method [35].

The mechanical composition of the marc was determined by weighing its components on the scales [11, 36, 37]. The amount of dry matter in the raw material was determined after drying the sample at 105 ° C until a constant weight was obtained [30]. The amount of dry matter in the extracts was determined by the refractometric method [26], and the amount of cellulose - by the method of Kirschen and Ganek. 1 g of the crushed product was placed in a test tube of 120 cm3 volume, 40 cm3 of an acid mixture (3.6 cm3 of nitric acid with a density of 1.4 and 36.4 cm3 of an 80% acetic acid solution) were added, the test tube was closed and heated on a sand bath for 1 hour. The contents of the tube was filtered through a glass filter in a boiling state. After retrieval of the extract, the precipitate was washed 1-2 times in 0.2 ml of boiling alcohol solution of sodium hydroxide, and then washed several times with a mixture of distilled water and 10 cm3 of alcohol ether. The pure white precipitate was dried at 100 ... 105°C until a constant weight was obtained, and weighed on a desiccator after cooling [1]. To determine the amount of hemicellulose, a sample of the raw material was extracted in 6% sodium hydroxide at a temperature of 20 ... 25°C for 1 hour. The resulting solution was neutralized with hydrochloric acid, filtered through a pre-weighed filter and dried. The amount of hemicellulose was determined by the difference between the mass of the sample and the filtered mass [1]. The determination of lignin content is based on the Klason method [1]. The main components of the

chemical composition of marc, wine material and grape juice, the mass concentration of the total dry extract, titratable and volatile acids, as well as the content of ethyl alcohol are determined based on the methods specified in the standards [22, 23, 27-29], and the weight fraction of the pectin substances - based on the volumetric method of S. Rike [34]. The Nessler's method [1] was taken as the basis for the determination of total nitrogen content. The Lowry method was used for the determination of the mass fraction of protein [1]. The number of reducing substances was determined by the method of Bertrand [1]. The determination of vitamin "C" content was carried out according to the standard GOST 24556-89 "The products of processing fruits and vegetables. Methods for the determination of vitamin C". Quantitative determination of anthocyanins was carried out by spectrophotometrically by optical measurement of the acid yield at a wavelength of 520 nm. Microbiological control over the raw materials and obtained extracts was carried out in accordance with SanPiN 2.3.2.1078-01 "Hygienic requirements for safety and nutrition value of food products" [4]. Organoleptic characteristics of the extracts were determined in accordance with the standards [24, 25]. The light fastness of the extracts was determined on the basis of changes in the completeness of the solution exposed to direct sunlight for three months using a photoelectric colorimeter at different wavelengths. Resistance to high temperature was determined on the basis of changes in the completeness of the product, sustained while heating (80 ° C) and boiling (100 ° C), using a photoelectric colorimeter at different wavelengths. The qualitative and quantitative analysis of the biologically active ingredients of the extracts was carried out by high-performance liquid chromatography [21].

Discussion of the results: The parallel experiments were conducted on the wine processing line in order to study the effects of drying type of the marc on the process of alcoholic fermentation. Grape dietary fibers, obtained as a result of two methods of drying, based on our technology - infrared radiation and drying cabinet, were used during the experiment. Dietary fibers are obtained from white sweet marc of mixed varieties of white grape. Dried dietary fibers are dispersed by various degrees of grinding and assorted using sieves (Table 4.5).

Table 1. Specification of experiment options

Option №	Drying method	Grinding degree of the fiber
1 (control)	control	control
2	infrared	1 mm
3	infrared	3 mm
4	infrared	5 mm
5	infrared	Unground
6	drying cabinet	1 mm

7	drying cabinet	3 mm
8	drying cabinet	5 mm
9	drying cabinet	Unground

The juice of Bayan Shirey grape variety has been fermented with the use of active dry yeast of the species Saccharomyces cerevisiae Killer Bayanus, race IOS 18-2007, pre-immobilized on options of grape dietary fiber. The control sample was fermented by “free” yeast cells (without using grape dietary fiber).

Immediately after adding the yeast immobilized on particles of grape dietary fiber grinded to 1–3 mm into the material, the part of the grape dietary fibers submerged in the bottom of the tank, and large particles floated on the surface of the fluid.

On the second day, all the options dimmed. This indicates the beginning of fermentation and the accumulation of yeast biomass. With the exception of the sixth (dietary fiber size of 1 mm, dried in a drying cabinet) and the second option (dietary fiber size of 1 mm, dried in an infrared dryer), in all other options, foam was formed. This characterizes the formation of carbon dioxide and the onset of sugar fermentation. In the second and sixth options, this happened on the third day, which indicates the intensity of the lag-phase. At this phase, the yeast reproduce, a constant movement of particles is observed throughout the volume, and the fermenting juice becomes even more turbid.

After fermentation, the wine materials are allowed to settle. In the second, third, sixth and seventh options (grape fibers, grinded into particles of 1-3 mm in size), grape dietary fibers together with yeast formed a thick precipitate. This facilitated the subsequent process of decanting. In the fourth and eighth options (grape dietary fibers, grinded to 5 mm), a part of the fibers, together with yeast, formed a sediment (pulp) at the bottom of the tank, and another part formed a “cap”. All the fibers that were used in the options with grinded grape dietary fibers floated on the surface of the liquid.

The nature of the change of dry substances during the fermentation of juice with the participation of grape dietary fiber is graphically shown in Figure 1 and Figure 2.

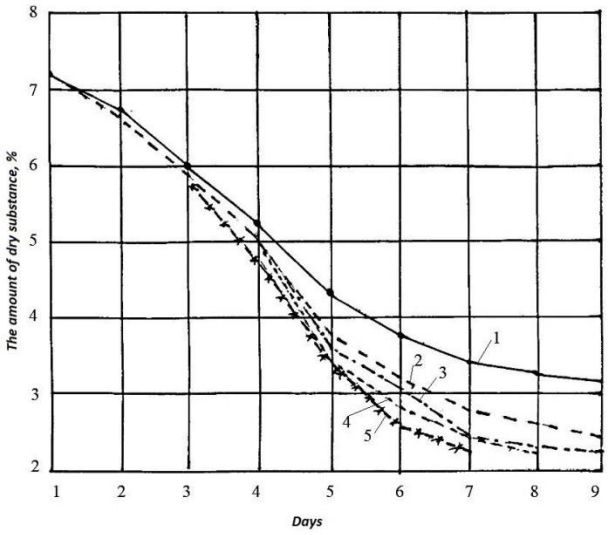

Fig.1. The change in the amount of dry substances during the fermentation of the juice using yeast immobilized on grape dietary fiber dried in an infrared dryer:

1- control option; 2- the 5th option; 3- the 2nd option; 4- the 4th option; 5- the 3rd option.

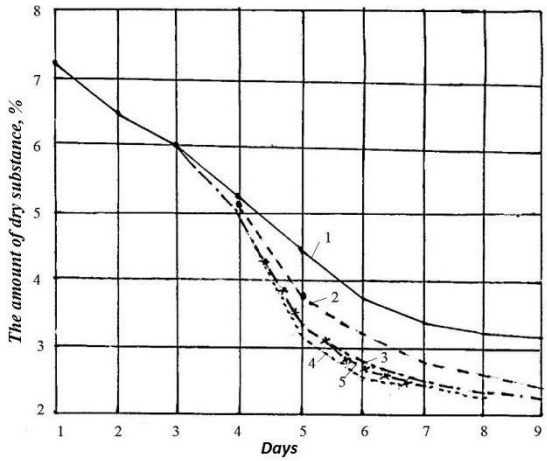

Fig.2. The change in the amount of dry substances during the fermentation of the juice using yeast immobilized on grape dietary fiber dried in a drying cabinet:

1- control option; 2- the 9th option; 3- the 6th option; 4- the 7th option; 5- the 8th option.

It has been established that immobilization of yeast cells on grape dietary fiber helps alcohol to intensify the process of fermentation. The best results are obtained with the use of dietary fiber, grinded into particles of 3-5 mm in size. At the same time, the duration of fermentation is reduced, and complete sugar fermentation is achieved.

It should be noted that in the third sample (dietary fibers were grinded to 3 mm and dried via infrared rays) the duration of fermentation was reduced by 2 days.

To understand how grape dietary fibers affect the color of the wine produced, the total dying intensity (total optical density at 420 and 520 nm wavelength) was determined (Fig. 3). Low rates of dying intensity characterize the low dying of the wine without golden and amber tint. This situation is positively estimated for white natural table wine materials.

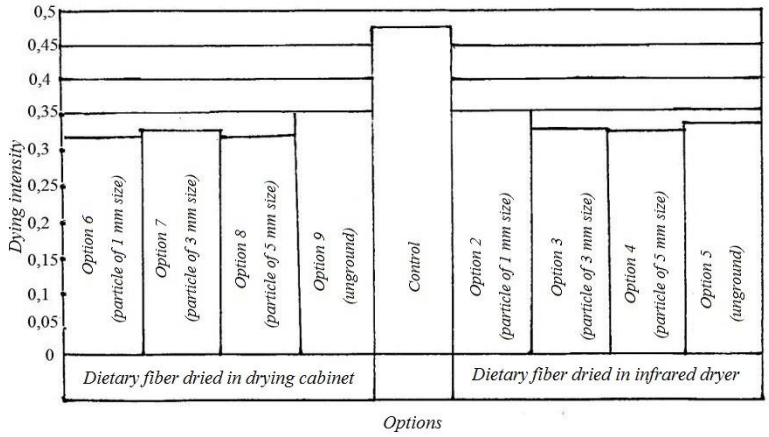

Fig.3. Influence of the drying method and grinding degree of grape dietary fiber on the dying intensity of wine materials.

In all options of the use of dietary fiber, the dying intensity was lower compared with the control variant. Samples 3, 4, 5, 6, 7, 8 acquired a light straw color. The 9th sample (dietary fibers grinded and dried in the drying cabinet) acquired a yellowish-golden tint, and the control option – a straw color.

The rate of wine extract is influenced by the degree of maturity of the grapes, as well as substances accumulated during fermentation, including glycerin and other non-volatile polyhydric alcohols, nitrogen and minerals, acids and their salts, and other extractive substances. Based on the mass concentrations of the above extract (Fig. 4), it can be noted that during fermentation, the wine is enriched with biologically valuable components of dietary fiber. Their transition into wine depends on the grinding degree and drying method.

While using dietary fiber dried in a drying cabinet in options 6–9, the total dry extract was in the range of 18.8 ... 20.9 g/dm3. The quantity of total dry extracts in the options where dietary fibers dried in an infrared dryer were used made up 19.4 ... 21.8 g/dm3.

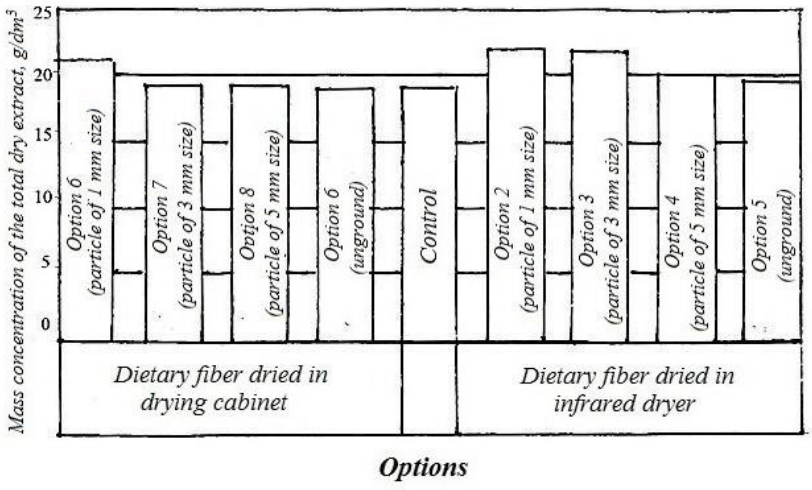
Mass concentration of the total dry extract, g/dm3
25
20
15
10
5
0
Option 6 (particle of 1 mm size)
Option 7 (particle of 3 mm size)
Option 8 (particle of 5 mm size)
Option 6 (unground)
Control
Option 2 (particle of 1 mm size)
Option 3 (particle of 3 mm size)
Option 4 (particle of 5 mm size)
Option 5 (unground)
Dietary fiber dried in drying cabinet
Dietary fiber dried in infrared dryer
Options

Fig.4. The influence of the drying method and the grinding degree of grape dietary fiber on the mass concentration of the extract.

It was found that the concentration of the total dry extracts in the samples, where grape dietary fibers dried in a drying cabinet and grinded to 1 mm were used, made up 2.1 g/dm3 more compared to the control option. And when using dietary fibers of the same size, dried in and infrared dryer, the extract made up 3 g/dm3 more compared to the control option. This indicates that infrared-dried material is of higher quality.

The use of grape dietary fiber in the fermentation process leads to a decrease in the mass concentration of phenolic compounds, which play a role in the dying of wine. Phenolic compounds correlate with the above mentioned dying intensity indicators. The addition of dietary fiber, dried via infrared radiation, has lower extractive mass and phenolic substances (Fig. 5). It is very important in the production of a natural white wine. As in the production of such type of wine it becomes necessary to activate the oxidation process with the participation of phenolic compounds. The grinding degree of dietary fiber also affects the amount of phenolic compounds. The higher the grinding degree the smaller the amount of phenolic compounds in the experimental options.

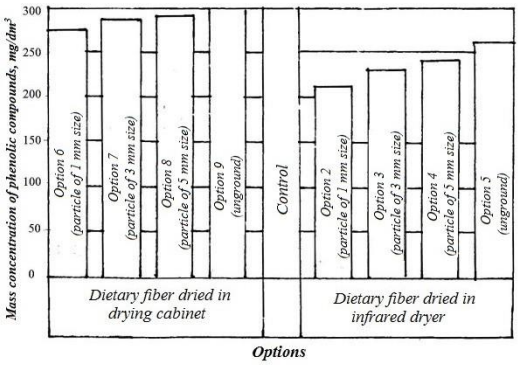

Fig.5. The influence of the drying method and the grinding degree of grape dietary fiber on the mass concentration of phenolic compounds.

The values obtained in the course of the experiment (Table 2, Table 3) show that grape dietary fiber has a significant effect on the chemical composition of the wine material, in particular on glycerin and organic acids. It should be noted that there is a high correlation between the mass concentration of the total dry extract and glycerin. This indicates that the use of dietary fiber helps the fermentation process to pass through glyceropyrograpе and produce a large amount of glycerin.

In the experimental options, in particular in the 6th, 7th, 3rd and 5th options, a significant decrease was observed in the concentration of malic acid, which may be due to the activation of the enzyme system in the tricarboxylic acid cycle.

Table 2. The influence of the drying method and the grinding degree of grape dietary fiber on the physico-chemical indicators of wine material

Options	Volume ration of ethyl alcohol, %	Mass concentration of acids, g/dm³		pH	Glycerin, g/dm³
		titratable	volatile		
1st (control)	9,25	8,4	0,56	3,09	4,12
2nd (infr, 1 mm)	8,56	6,2	0,28	3,08	6,70
3rd (infr, 3 mm)	8,56	6,0	0,33	3,11	6,55
4th (infr, 5 mm)	8,48	5,9	0,32	3,11	6,60
5th (infr. unground)	8,16	5,7	0,34	3,10	6,82
6th (cab, 1 mm)	9,78	6,9	0,43	2,91	6,08
7th (cab, 3 mm)	9,52	7,2	0,31	2,88	5,78
8th (cab, 5 mm)	9,85	7,4	0,33	2,87	5,25
9th (cab, unground)	9,25	7,2	0,36	2,76	4,88

Table 3. The influence of the drying method and the grinding degree of grape dietary fiber on the mass concentration of organic acids

Options	Organic acids, g/dm³

	Tartaric	Malic	Citric	Succinic	Lactic
1st (control)	4,77	1,98	0,47	0,87	1,80
2nd (infr, 1 mm)	2,43	1,13	0,36	0,74	1,54
3rd (infr, 3 mm)	2,28	1,23	0,36	0,68	1,54
4th (infr, 5 mm)	1,82	1,28	0,38	0,58	1,37
5th (infr. unground)	1,96	1,47	0,30	0,56	1,28
6th (cab, 1 mm)	4,32	1,61	0,27	0,79	2,21
7th (cab, 3 mm)	4,50	1,66	0,28	0,76	2,18
8th (cab, 5 mm)	4,66	1,91	0,29	0,73	2,09
9th (cab, unground)	4,56	1,96	0,34	0,70	1,92

A statistical processing of the experimental values of the amount of glycerin was carried out. It is proved that glycerin collection of fibers is influenced more by the drying method rather than the grinding degree of dietary fibers. The obtained report values proved that the chemical composition of the produced wine materials is more influenced by the type of drying OACACAAF grape dietary fiber than the degree of its grinding. Based on the results of research, it can be noted that infrared drying provides higher quality grape dietary fiber.

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